Clean Air Status and Trends Network (CASTNET)

A monitoring network established to measure concentrations of key air pollutants involved in acid deposition, CASTNET has been an essential tool for evaluating EPA's emission reduction programs.

Program Overview

CASTNET is a regional long-term environmental monitoring program administered and operated by EPA's Clean Air Markets Division (CAMD). Developed from the existing National Dry Deposition Network (NDDN), CASTNET was established in 1991 under the Clean Air Act Amendments. The regional monitoring network was formed to assess trends in acidic deposition due to emission reduction regulations, such as the Acid Rain Program (ARP) and NO_x Budget Trading Program (NBP). CASTNET has since become the nation's primary monitoring network for measuring concentrations of air pollutants involved in acidic deposition affecting regional ecosystems and rural ambient ozone levels.

CASTNET is able to provide data needed to assess and report on geographic patterns and long-term temporal trends in ambient air pollution and dry atmospheric deposition. CASTNET can also be used to track changes in measurements associated with climate change (such as temperature and precipitation).

Network Description

Presently there are a total of 86 operational CASTNET sites located in or near rural areas and sensitive ecosystems (see map on page 2) collecting data on ambient levels of pollutants where urban influences are minimal. As part of an interagency agreement, the National Park Service (NPS) sponsors 27 sites which are located in national parks and other Class-I areas designated as deserving special protection from air pollution.

A long-term network with consistency in monitoring methodologies, such as CASTNET, which has over 40 sites with more than 15 years of continuous operations, is a valuable resource for regulatory accountability. CASTNET complements the National Atmospheric Deposition Program/National Trends Network (NADP/NTN), which is considered the nation's primary source for wet deposition data. Together, these two monitoring programs provide data necessary to estimate temporal and spatial trends in total deposition (wet and dry) as well as ecosystem health (e.g., monitoring data on lakes, streams, and forests). Data from CASTNET and NADP are used to assess the effectiveness of emission reductions from EPA regulations such as reductions in SO_2 and NO_x from the NO_x SIP Call and the ARP. CASTNET measurements also are used in the development and evaluation of numerical models created for regulatory assessment and an understanding of atmospheric processes. Over the next five years, CASTNET will also serve as an assessment tool for the Clean Air Interstate Rule (CAIR).

Wet deposition *is the portion of total atmospheric deposition dissolved in cloud droplets and deposited during rain and other forms of precipitation.*

Dry deposition *is the portion of atmospheric deposition that settles as dust or deposits on dry surfaces during periods of no precipitation.*

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

CLEAN AIR MARKET PROGRAMS

Changes in Deposition and Rural Ozone Concentrations

Deposition Measurements

At each site, there is a temperature-controlled shelter which houses a computer, a data logger, and a continuous ozone monitor. Weekly samples of particulate matter and select gasses are collected using a 3-stage filter pack with a controlled flow rate located atop a 10m tower. For quality assurance, site audits are performed once every six months and biennially by the CASTNET contractor and a third party auditor, respectively.

CASTNET Site Map (as of December 2007)

Network Summary

Initiated	1986*
Number of Sites (as of December 2007)	86**
Sampling Schedule	7-day averages (Tuesday to Tuesday)
Ambient Measurements Gaseous	Sulfur Dioxide (SO_2) Nitric Acid (HNO_3) Ozone (O_3) [hourly]
Particulate	Sulfate (SO_4^{2-}) Nitrate (NO_3^-) Ammonium (NH_4^+) Other relevant ions
Meteorological Parameters (1-hour averages)	Temperature (2 and 9 meters) Wind Speed and Direction Sigma Theta Solar Radiation Relative Humidity Precipitation Surface Wetness
Land Surface Features	Leaf Area Index and Vegetation Land Use and Terrain

* The National Deposition Network (NDDN) was established in 1986 and field measurements began in 1987. With the passage of the Clean Air Act Amendments of 1990, NDDN was entirely subsumed by CASTNET in 1991.

** Two sites are collocated (MCK131/MCK231 and ROM406/ROM206).

Dry deposition fluxes (D) cannot be measured, but instead are calculated from the product of deposition velocities (Vd) and concentration of a pollutant (C). Dry deposition (D=CVd) is calculated from the weekly filter pack samples and meteorological measurements collected using the Multi-Layer Model (MLM).

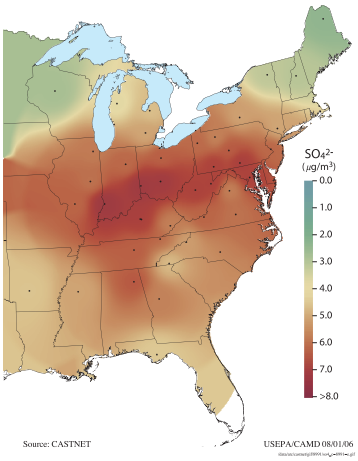
Total deposition is the sum of estimated dry deposition fluxes from CASTNET sites and wet deposition measured at NADP sites. NADP sites can be collocated with CASTNET sites or the wet deposition is estimated by inverse distance weighting from wet deposition measurements taken at nearby NADP sites.

For more detailed information on sampling procedures and estimating deposition values, refer to the CASTNET web page at http://epa.gov/castnet.

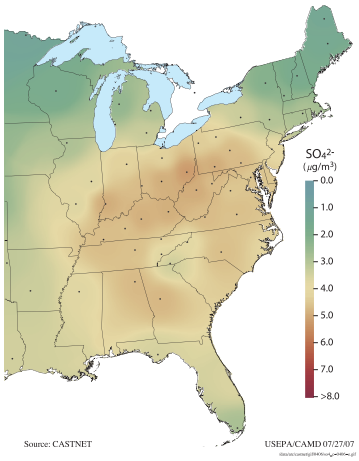
Regional Changes in Deposition

The maps on the next page show corresponding trends in dry sulfur and nitrogen deposition for the Eastern United States, between 1989–1991 and 2004–2006. With the implementation of the ARP in 1995, and the NBP in 1999, emission reductions have resulted in a dramatic decrease of total sulfur deposition in the Eastern United States (approximately 40%). Total nitrogen deposition has also decreased in the East (approximately 20%). Dry sulfur deposition has decreased significantly (39%) in the Eastern region from 1989–1991 and 2004–2006, while dry nitrogen deposition has decreased 17% during the same time period. The largest overall reductions for nitrogen and sulfur deposition have occurred in the Northeast region, downwind from the Ohio River Valley.

Trends in Ambient Sulfate Concentrations From 1989–1991 to 2004–2006

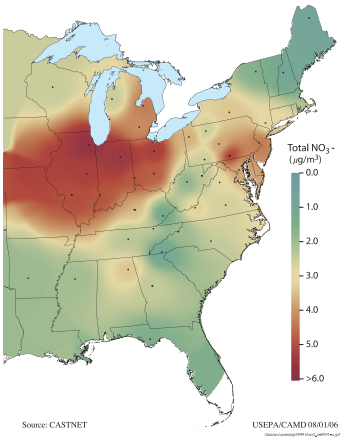


Average Sulfate Concentration 1989–1991

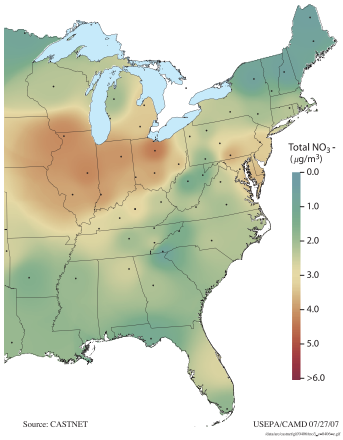


Average Sulfate Concentration 2004–2006

Trends in Ambient Nitrate Concentrations From 1989–1991 to 2004–2006

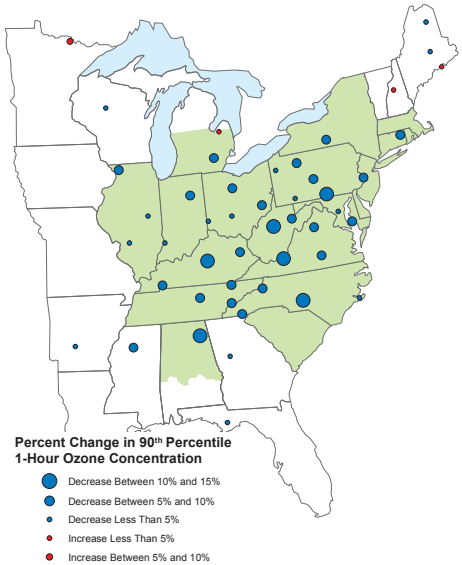


Average Nitrate Concentration 1989–1991

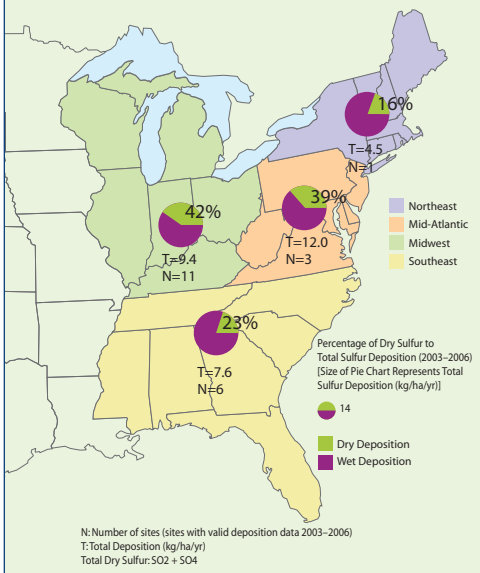


Average Nitrate Concentration 2004–2006

At each site there is a continuous ozone analyzer which measures and records hourly average concentrations. CASTNET is the primary network for measuring rural ozone concentrations and a vital assessment tool for EPA's NBP. As shown in the map on the right, there has been a decrease in the 90th percentile ozone concentration measured at each site located in the NBP region (shaded states) between 2000–2002 (prior to NBP implementation) and 2004–2006 (post NBP implementation).

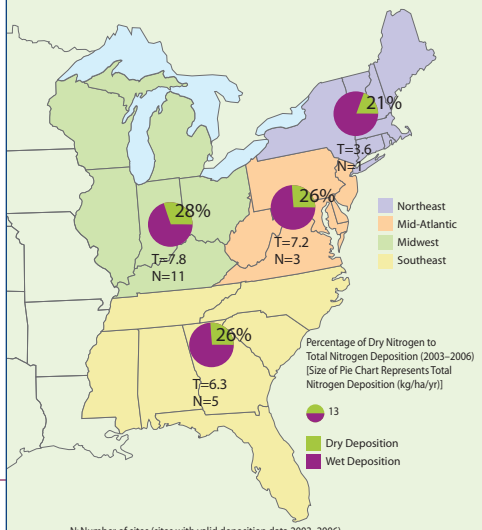


Percentage of Dry to Total Sulfur Deposition



N: Number of sites (sites with valid deposition data 2003–2006)
T: Total Deposition (kg/ha/yr)
Total Dry Sulfur: SO2 + SO4

Percentage of Dry to Total Nitrogen Deposition

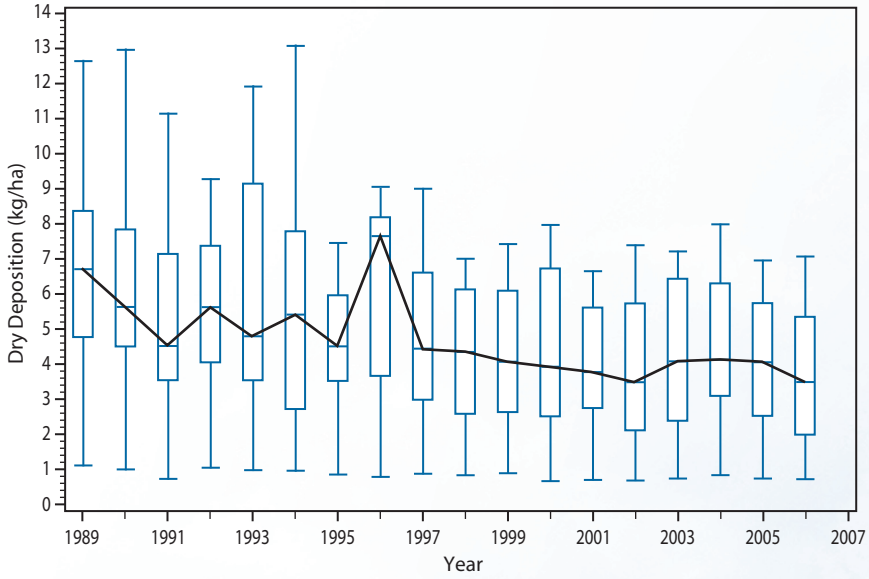


N: Number of sites (sites with valid deposition data 2003–2006)
T: Total Deposition (kg/ha/yr)
Total Dry Nitrogen: HNO3 + NO3 + NH4

The above maps are regional aggregations of sulfur and nitrogen deposition at Eastern sites averaged over the 2003–2006 period. The dry deposition component for sulfur varies between approximately 11%–60% at Eastern sites. The variation in dry sulfur deposition can be attributed to the proximity of large emission point sources in the Midwest region. Nitrogen deposition is typically more uniform across the East due to the large NO_x contribution from motor vehicles (see map above).

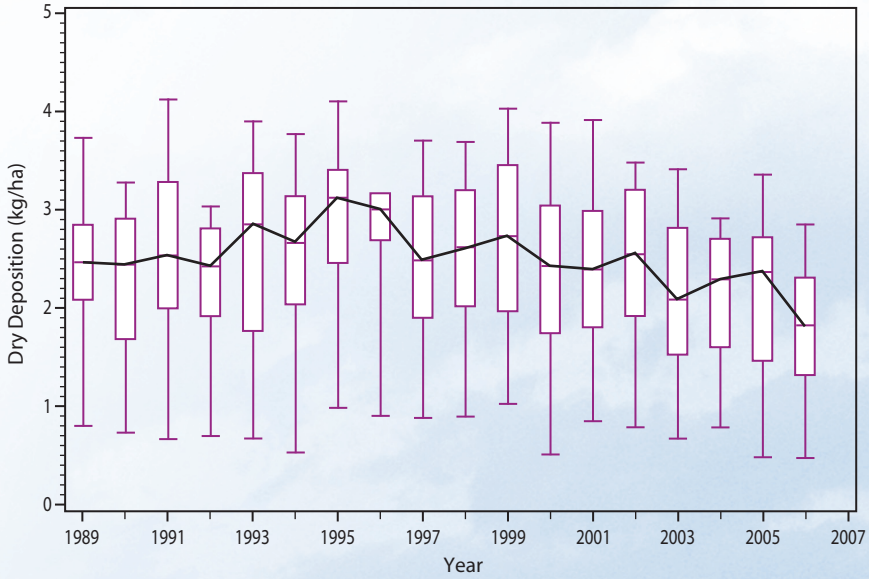
Regional Trends in Sulfur and Nitrogen Deposition

Trend in Sulfur Dry Deposition in Eastern U.S. 1989–2006



CASTNET has been operational for almost 20 years, giving EPA and other data users the ability to study trends in dry deposition for an individual site, region, or the entire nation. Due to EPA emission reduction programs, such as the ARP, regional dry sulfur deposition has decreased significantly in the Eastern United States. The largest decrease in regional dry sulfur deposition was in the Northeast (72%). Dry nitrogen deposition also has decreased in the Eastern region. The largest decrease (47%) in regional dry nitrogen deposition was, again, in the Northeast. The trend plots of dry nitrogen and sulfur deposition represent the 5th, 25th, 50th, 75th, and 95th percentiles calculated for the Eastern reference sites from 1989–2006.

Trend in Nitrogen Dry Deposition in Eastern U.S. 1989–2006



Monitoring Networks

For more information about networks that CASTNET collaborates with to provide regional and nationwide assessments of ambient air quality, please refer to the following websites:

National Atmospheric Deposition Program-National Trends Network (NADP/NTN) (wet deposition)
http://nadp.sws.uiuc.edu

National Atmospheric Deposition Program-Mercury Deposition Network (NADP/MDN) (mercury deposition)
http://nadp.sws.uiuc.edu/mdn/

Interagency Monitoring of Protected Visual Environments (IMPROVE) (visibility)
http://vista.cira.colostate.edu/improve

State and Local Ambient Monitoring Stations and National Air Monitoring Stations (SLAMS and NAMS) (urban ozone)
http://www.epa.gov/oar/oaqps/qa/monprog.html

Canadian Air and Precipitation Monitoring Network (CAPMON) (Canadian air quality monitoring)
http://www.msc.ec.gc.ca/capmon/index_e.cfm

Online Resources

CASTNET has 10 sites which report real-time hourly ozone data to the AIRNow website so users can access air quality forecasts or real-time air quality conditions by visiting http://airnow.gov. AIRNow is a web-based database created by EPA, NOAA, NPS, and tribal, state, and local agencies to improve the accessibility of air quality data to the public.

Note: The ozone data submitted to AIRNow have not gone through the extensive quality assurance that is used for regulatory purposes; therefore the data should be used as a public reference, not for publication.

For more information about CASTNET—including CASTNET data and maps, annual reports, and quality assurance information—visit http://www.epa.gov/castnet/.